

Review of the Genus *Aspidogyrus* Yoshimoto, with Descriptions of Three New Species (Hymenoptera: Cynipoidea: Eucoilidae)¹

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ABSTRACT. *Aspidogyrus* Yoshimoto 1962 is redescribed and compared with other endemic Hawaiian eucoilid genera. Three new species; *A. kidoi* from Kauai, *A. macioleki* from Oahu and *A. mirabilis* from Hawaii, are described and compared to the type species, *A. strigosus* Yoshimoto from Maui. The unique morphological characters exhibited by *Aspidogyrus* species are discussed. These appear to be adaptations that fit the wasps for life as parasites of fresh water aquatic Diptera larvae in swift-flowing streams.

Yoshimoto (1962) erected *Aspidogyrus* to accommodate an unusual Hawaiian eucoilid of unknown habits. His brief description of the genus and the single included species, *A. strigosus* Yoshimoto, provided few clues about its biology or taxonomic relationships. There have been no subsequent published references to *Aspidogyrus*, except for its inclusion in a key to Hawaiian eucoilid genera (Beardsley 1990), and a brief mention of its biological relationships (Beardsley 1991).

Although representatives of this genus have been rarely collected, specimens are now at hand from all of the larger islands in the main Hawaiian group (Kauai, Oahu, Molokai, Maui, and Hawaii). This material contains at least four species, each known with certainty from a single island. The Molokai record is based upon a single male specimen, and that form cannot be satisfactorily characterized until the female is known.

Aspidogyrus is a small, distinctive, endemic Hawaiian eucoilid complex with no apparent close relatives. Furthermore, specialized morphological adaptations exhibited by species of this genus, particularly the females, which facilitate the parasitization of larval Diptera in swift-flowing streams, appear to be unique within the family Eucoilidae. *Aspidogyrus* species are aquatic insects in that they seek out, parasitize and develop within the larvae of aquatic Diptera. The holotype female of *A. mirabilis*, new species, was collected while it was moving over a rock surface, underwater, in a swiftly flowing stream on Hawaii Island. The holotype female of *A. macioleki*, new species, emerged from the parasitized pupa of a canacaeid fly collected in an Oahu mountain stream, and several prepupal canacaeid larvae which were collected at the same time contain parasitoid larvae that may be this species. The Kauai form, *A. kidoi*, new species, was collected above a swift-flowing powerhouse stream that harbored canacaeid and ephydrid fly larvae. These ecological data, as well as the specialized morphology of the species, show that *Aspidogyrus* is an endemic Hawaiian complex which has

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become specialized to parasitize aquatic Diptera in streams. In a parallel development, the endemic Hawaiian subgenus *Nesokleidotoma* Beardsley (1991) of the widespread genus *Kleidotoma* Westwood also has specialized as parasitoids of stream-inhabiting Diptera. In that group two species (or species complexes) are present, one attacking larvae of endemic Ephydriidae and the other larval Canacaeidae. Although the only confirmed host of an *Aspidogyrus* species is an undetermined canacaeid, the possibility exists that this genus also may contain two parallel species complexes, each utilizing one of these two dominant groups of endemic, stream-inhabiting cyclorrhaphous Diptera. For example, several males collected on Hawaii Island do not appear to be conspecific with *A. mirabilis*, but are very close to the allotype male of *A. strigosus* from Maui. Therefore, it appears that at least two species of *Aspidogyrus* are present on Hawaii Island. The unique male from Molokai is very similar to the male of *A. kidoi* from Kauai, suggesting that a representative of the *mirabilis-kidoi* complex occurs on Molokai. Obviously, additional field work and specimens are required before the taxonomic and biological relationships within this genus can be clarified.

Types of new species described in this paper are deposited in the Bernice P. Bishop Museum, Honolulu.

Genus *Aspidogyrus* Yoshimoto

Aspidogyrus Yoshimoto 1962:840.

Type species: *Aspidogyrus strigosus* Yoshimoto.

Yoshimoto briefly defined *Aspidogyrus* as follows:

"Female antenna 13-segmented; antennal segment 3 slightly longer than 4 or 5; club composed of 8 segments. Male antenna 15-segmented; segment 3 emarginate on inner side. Forewing pubescent, ciliate along margin, radial cell closed. Anterior pits of scutellum striate; anterior 1/2 of scutellar disc narrow and entire disc punctate-rugose; scutellar cup more or less circular-shaped and surface slightly convex; lateral bar smooth. Tergite 2 with hairy ring. Prothorax, mesopleuron and metapleuron with longitudinal striations."

Yoshimoto contrasted the genus with "*Ganapis*" (sic!, presumably *Ganaspis* Förster 1869) and stated that *Aspidogyrus* differs in having the scutellar plate not flattened in profile and "by the punctate-rugose scutellar disc and striations on prothorax and meso- and metapleuron"

Aspidogyrus does not appear to be closely related to *Ganaspis* or to endemic Hawaiian genera of the *Ganaspis* complex (e.g.: *Hypodiranchis* Ashmead, *Weldia* Yoshimoto, *Nesodiranchis* Perkins). In the *Ganaspis* group, as defined by Nordlander (1982) the ridge that marks the posterior margin of the metapleurite is normally interrupted near its midlength, where the margin is more or less depressed. Also, in that group the middle and hind coxae bear characteristic groups of short, fine setae. These character states were not found in *Aspidogyrus*.

The following descriptive information is presented to more completely characterize this genus. **Female:** Antennae and legs conspicuously elongated and slender; antennae with outer flagellomeres shorter than basal, which are sometimes conspicuously elongated (fig. 1A), flagellomeres slightly broader toward apex of antenna but not forming a definite club. Tarsi relatively elongate, particularly apical tarsomere which is as long as, or longer than basal tarsomere; pretarsus with enlarged divided claws, empodium normal or enlarged. Mesosoma with well-developed integumental sculpture consisting of raised reticulate or longitudinal ridges on thoracic pleura, and strong, coarse areolate-rugose sculpture on scutellar disc; basal scutellar pits weakly separated from scutellar disc, their surface costulate or reticulate. Scutellum not strongly raised and extending behind slightly over base of propodeum. Body setae very sparse except on sides of scutellar disc adjacent to wing bases and on propodeum, which bear dense pile of fine, decumbent setae. Mesopleuron with linear subalar pit present near posterior end of dorsal margin. Metapleuron with ridge on posterior margin entire, or narrowly interrupted near midlength, not depressed mesally; anterior ventral margin without a hair-bearing pocket. Wings relatively long and narrow, with very dense, fine setae covering both surfaces. Petiole of gaster of relatively uniform width or slightly, gradually wider posteriorly, not abruptly widened as in *Cothonaspis* Hartig. Gaster with basal hair ring consisting of a single row of fine setae, continuous dorsally, reduced (incomplete dorsally), vestigeal (a few setae laterally) or absent.

Male: Similar to female in integumental sculpture, but usually less strongly developed; appendages less noticeably modified for aquatic habits. Legs, particularly tarsi, less strongly developed; wings less densely setose.

KEY TO FEMALES OF *ASPIDOGYRUS*

1. Sides of mesosoma costulate with more or less longitudinal ridging; mesoscutum entirely smooth and shining; antenna with segments 3-9 moderately elongate, 3 distinctly less than twice as long as segment 12; tarsal claws trifid (fig. 2A); basal hair ring of gaster present, complete dorsally; Maui, Hawaii? *strigosus* Yoshimoto
- Sides of mesosoma mostly areolate or reticulate-rugose; mesoscutum with at least lateral margin areolate; antenna with segments 3-9 more elongate, 3 twice as long as 12 or nearly so; tarsal claws either bifid (fig. 1C) or with a single point plus a comb of 5-6 fine straight projections (fig. 2B); basal hair ring of gaster vestigeal or absent 2
2. Tarsal claws distinctly bifid, empodium not conspicuously developed; mesoscutum finely areolate-reticulate over most of surface 3

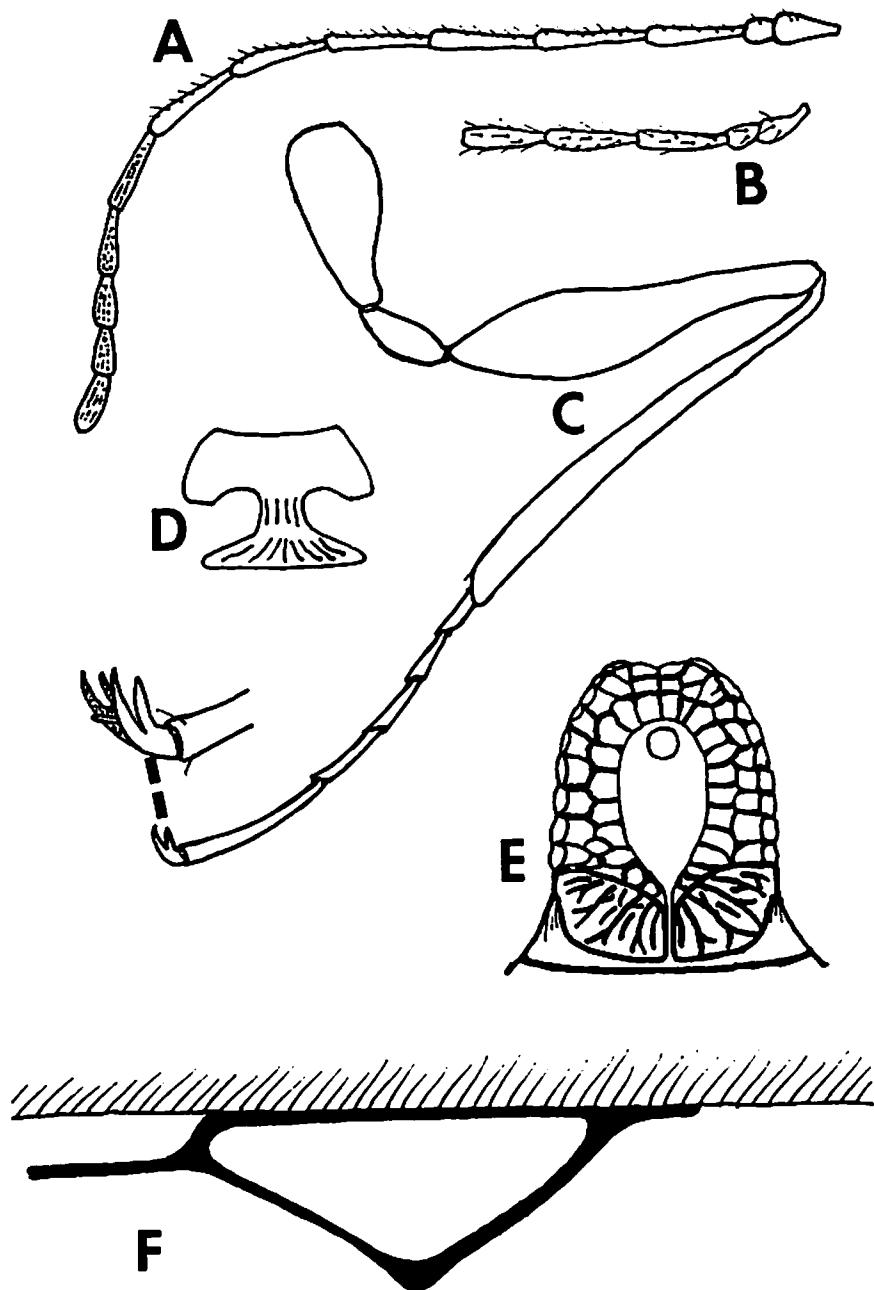


FIGURE 1. *Aspidogyrus mirabilis* n. sp.; A, female antenna; B, male antenna, basal segments; C, female hind leg (setae omitted); D, female pronotal plate; E, dorsal aspect of female scutellum; F, female forewing radial cell (discal setae omitted).

- Tarsal claws with a single point plus a comb of 5 or 6 fine straight projections on inner face; empodium large, conspicuous, extending beyond apex of claw (fig. 2B); mesoscutum mostly smooth, shining, narrowly areolate on lateral margin; Oahu *macioleki*, n. sp.
- 3. Temples behind eyes distinctly costulate; mesosoma more strongly sculptured, mesoscutum strongly areolate reticulate except for narrow mid-dorsal longitudinal strip; Kauai *kidoi*, n. sp.
- Temples behind eyes smooth except for a few minute setigerous punctures, shining; mesosoma less strongly sculptured, mesoscutum smooth and shining in a broad mesal longitudinal band as well as sublaterally near midlength; Hawaii *mirabilis*, n. sp.

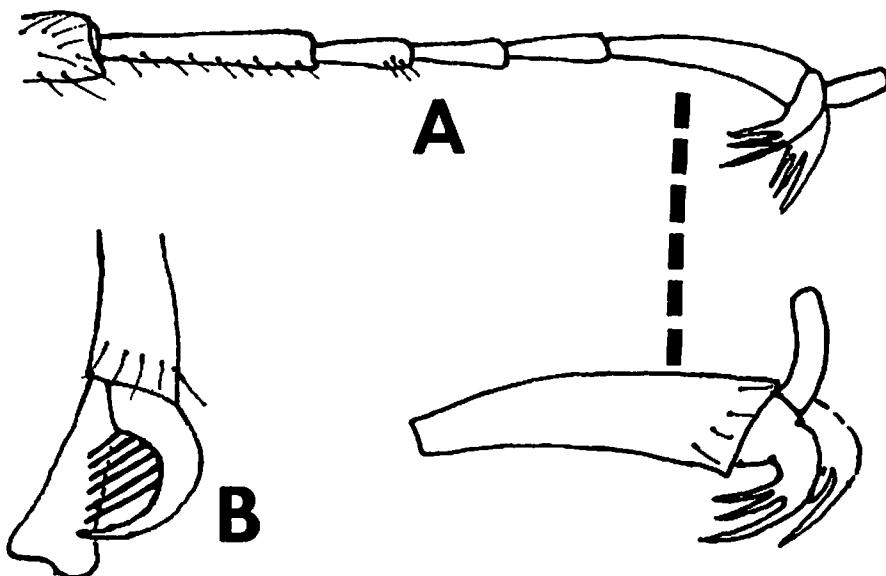


FIGURE 2. A, *Aspidogyrus strigosus*, female hind tarsus; B, *A. macioleki* n. sp., female pretarsus (second claw omitted).

Aspidogyrus strigosus Yoshimoto (fig. 2A, 3A-B).

Aspidogyrus strigosus Yoshimoto 1962. Pacific Insects 4:840.

The holotype and allotype specimens, from Nahiku, Maui, were examined. No other conspecific females were available, although some Hawaii Island males, discussed below, may belong here. This species differs in several respects from the three new species described below, which seem to form a natural group. It is the only species in which integumental sculpture of mesosomal pleura is formed by more or less longitudinal

ridges; in the others this sculpture is areolate-rugose. It is the only species in which the mesoscutum of the female is entirely smooth; in the others it is partly to mostly areolate to areolate-rugose. It is the only one of the four in which the basal hair ring is complete in both sexes; in others it is incomplete, vestigial or absent. Additional features of *strigosus* not found in the three other species are the trifid tarsal claws, the relatively short apical tarsomere (about as long as basal) and the relatively short basal antennal flagellomeres (segment 3 less than twice as long as 12).

The presence of males similar to the allotype of *strigosus* in the Kohala Mts. of Hawaii Island is taken as evidence that this, or a closely related species, occurs there. However, females are required for confirmation. These males differ from the *strigosus* allotype in having somewhat more elongate antennae, and in most, somewhat more strongly developed mesosomal sculpture. The significance of these differences cannot be adequately evaluated at this time.

Of the seven Hawaii *strigosus*-like males available, six were collected in the Kohala Mts. at Honokane Nui Stream, where the type and allotype of *A. mirabilis* also were taken. The seventh specimen is in poor condition and is labeled: Hawaii, Wailuku River, 1971, M. Delfinado; and: "removed from canaceaid puparium".

Aspidogyrus strigosus is the least highly specialized of the four presently known species of this genus. The female antenna, particularly the basal flagellomeres, is less elongate in this species, and the entire antenna is shorter than the body. The legs also are less elongate, the apical tarsomere of the hind tarsus being approximately the same length as the basal one (fig. 2A), instead of much longer.

Aspidogyrus mirabilis, new species (fig. 1).

Female: Length 1.7mm, forewing 1.9mm. Head and thorax black, gaster dark brown, antenna and hind legs brown, fore and middle legs yellowish brown. Head not quite as wide as thorax, in dorsal aspect about $\frac{2}{3}$ as long as wide, front between eyes about twice as wide as eye; malar distance about $\frac{5}{6}$ height of compound eye; eye relatively small, height less than $\frac{1}{2}$ height of head; subocular suture present, weakly developed. Head smooth, shining, without striations or carinulae on temples, occiput or malar areas; setae absent except for a few fine scattered hairs on occiput and temples. Antennae (fig. 1A) as long as body, slender, segments 3-8 subequal, at least 6 times as long as maximum width, segments 9-12 progressively shorter and slightly broader, 13 about as long as 11; rhinaria apparently confined to segments 9-13; antennae largely devoid of setae; a few short, fine setae along upper margins of segments 1-8.

Pronotal plate well defined, posterior (upper) and lateral margins forming a fine ridge, posterior margin nearly straight (fig. 1D), surface of posterior (upper) portion smooth, a few setae along its anterior margin, mesal bridge and anterior part of plate with very fine, smooth wrinkles. Sides of pronotum distinctly areolate-rugose over entire surface, a distinct carina, with impressed groove just above, bordering margin adjacent to

propleuron. Mesoscutum laterally areolate-rugose, most strongly so along pronotal margin and on postero-lateral corners, sculpture becoming evanescent mesally and completely absent in a mesal strip extending from pronotal margin to about the midlength, this region bounded laterally by weak longitudinal lines which may be vestigial notaulices. Scutellum not strongly elevated, the dorsum of the plate forming an almost smooth continuation of curve of mesoscutum, extending slightly behind over base of propodeum; disc (fig. 1E) strongly areolate-rugose throughout, apex semi-truncate; basal fossae shallow, surface with diagonally transverse, weakly anastomosing carinulae; scutellar plate (fig. 1E) relatively narrow, elongate-oval, extending about $\frac{2}{3}$ length of disc, about $\frac{1}{3}$ as wide as maximum width of disc, surface smooth, shining, slightly downcurved posteriorly, with a narrow, declivous, anterior neck and moderately small circular subapical pit. Mesopleuron with upper portion strongly areolate-rugose over most of surface; metapleuron with posterior margin marked by a nearly continuous ridge, briefly interrupted near midlength.

Forewings relatively long and slender, ratio of length (excluding fringe setae) to maximum width 10:3; both surfaces densely covered with short fine setae. Fringe setae very close together, length of longest (outer portion of hind margin) slightly less than width of radial cell. Radial cell (fig. 1F) nearly three times as long as wide. Legs elongate, slender (fig. 1C), tarsi nearly as long as tibiae, apical tarsomere slightly shorter than the 3 preceding combined, pretarsus (fig. 1C) with claws enlarged, each distinctly bifid, with a finger-like empodium between.

Gaster smooth, shining, without basal hair ring, with 4 widely separated setae on each side near base of second tergite; two additional tergites indicated posteriorly.

Male: Similar to female but integument less strongly sculptured, mesoscutum mostly smooth, shining, weakly, narrowly areolate-reticulate on lateral margins, mesopleuron areolate-rugose throughout, but less strongly than female. Compound eye larger than female, height of malar space about $\frac{1}{2}$ height of eye. Antenna 15-segmented, longer than body, third segment (basal flagellomere) subequal to or a trifle longer than fourth, not noticeably curved or incised; following segments each very slightly shorter than preceding, apical segment about $\frac{1}{6}$ as long as fourth; all segments sparsely setose. Legs elongate but not modified as in female; tarsi with basal tarsomere longest, pretarsus not enlarged. Gaster with incomplete basal hair ring composed of a vertical row of close-set erect hairs on each side, broadly interrupted dorsally. Second tergite covering about $\frac{2}{3}$ of gaster, additional free tergites exposed posteriorly.

Holotype female: Hawaii, Kohala Mts., Honokane Nui Stream, E. Fork, 1150 feet, 12•VIII•1970, J.A. Tenorio, walking on stones underwater in stream.

Allotype male: same locality as holotype, 11•VIII•1970, D.E. Hardy (apparently taken by net).

This species is close to *A. kidoi* from Kauai. It can be distinguished by the absence of integumental sculpture on the temples and vertex of the head, the less strongly developed integumental sculpture of the mesosoma, particularly the mesoscutum, and in the female the smaller compound eye and correspondingly wider malar space.

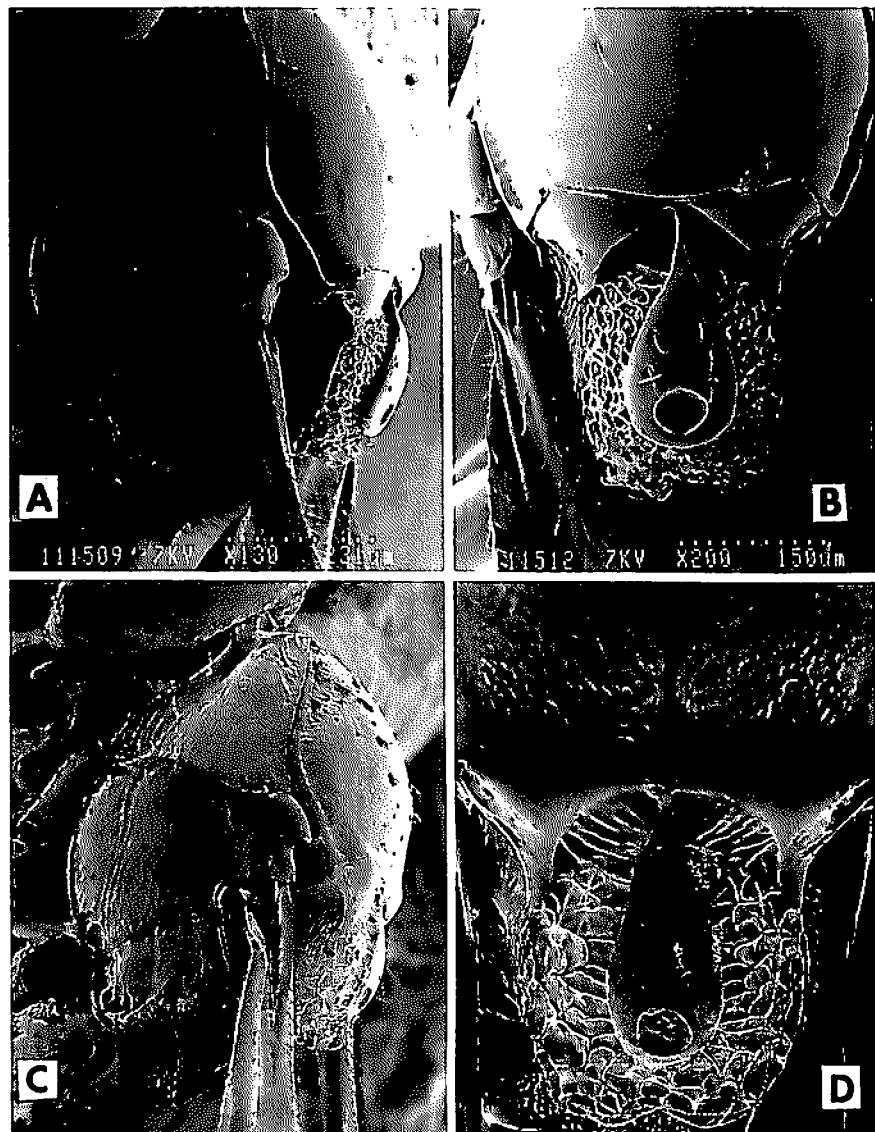


FIGURE 3. A-B, *Aspidogyrus strigosus* Yoshimoto?, male, mesosoma; A, lateral; B, dorsal; C-D, *A. kidoi* n. sp., male, mesosoma; C, lateral; D, dorsal.

Aspidogyrus kidoi, new species (figs. 3C-D).

Female: Length 1.6mm, forewing 1.8mm. Head and mesosoma black; gaster and hind coxa very dark brown; tegulae, wing veins, and remainder of appendages somewhat lighter brown. Head slightly narrower than thorax (7:8), in dorsal aspect about $\frac{4}{7}$ as long as wide; compound eye somewhat larger than in *A. mirabilis*, height about $\frac{1}{2}$ of height of head; malar space about $\frac{5}{8}$ of height of eye; subocular suture present. Head largely smooth and shining except temples behind eyes and vertex behind ocelli finely carinulate, carinulae mostly dorsoventrally oriented on temples, mostly transverse on vertex, carinulae sometimes anastomosing, a narrow smooth area immediately adjacent to eye margin above, becoming broader below; sides of antennal tubercles finely carinulate below and laterad of toruli. Antennae very similar to *A. mirabilis*, a trifle longer than body, slender, segments 3-8 very elongate, at least 6 times as long as maximum width, segment 3 (basal flagellomere) longest, 4 subequal, 5-8 each progressively slightly shorter than preceding; rhinaria present on segments 9-13, 9-12 each progressively shorter than preceding and slightly wider at apex, 13 slightly longer than 12; antenna with a few short, fine setae on upper margins of segments 1-9.

Pronotal plate well defined, posterior and lateral margins forming a fine ridge, posterior nearly straight, as in *A. mirabilis*, other details not visible in holotype. Sides of pronotum finely, strongly areolate over entire surface. Mesoscutum finely, strongly areolate-rugose over most of surface, somewhat smoother and more shining in a mesal longitudinal band extending from anterior margin about $\frac{3}{5}$ of length, this area with weakly developed longitudinal carinulae. Scutellum similar to *A. mirabilis*, hardly elevated, extending slightly behind over base of propodeum; disc coarsely, strongly areolate-rugose throughout, apex semi-truncate; basal fossae shallow, surface carinulate with carinulae diagonally transverse; base of scutellum cephalad and laterad of fossae smooth and shining. Scutellar plate extending about $\frac{3}{4}$ length of disc, elongate-oval in shape, slightly arched front to back, smooth, shining, with moderately small subapical pit, basal neck extremely narrow, resembling a raised carina. Meso and metapleuron finely, strongly areolate-rugose throughout, mesopleural suture obsolete; hind margin of metapleuron with ridge entire. Propodeum and metanotum with dense pile of fine setae.

Legs very elongate, as in *A. mirabilis*. Hind tarsi with apical tarsomere longest, slightly shorter than three preceding tarsomeres combined; tarsal claws strongly developed, bifid; empodium not enlarged.

Wings elongate, narrow, both surfaces with very dense fine setae, veins dark, strongly indicated.

Gaster with basal hair ring absent, a few setae scattered on sides of second tergite; posterior tergites narrowly exposed at apex.

Male: Similar to female but integumental sculpture less strongly impressed. Antennae 15-segmented, elongate, similar to *A. mirabilis*, basal flagellomere (third segment) longest, curvature weakly developed, outer flagellomeres

gradually becoming shorter toward apex, penultimate shortest, about $\frac{2}{3}$ as long as basal; rhinaria present on all flagellomeres. Wings much less densely setose than in female. Hair ring of gaster present but incomplete, represented by a line of fine setae on each side, broadly interrupted mesally.

Holotype female, allotype male and one male paratype: Hawaiian Islands: Kauai I., Wainiha main stream, powerhouse, 13•III•1991, M. Kido collector. Four male paratypes: same locality, Wainiha River at tailrace, IV•1991, same collector, and two male paratypes, same data except: at powerhouse IV•1991, same collector.

This species is named in honor of the collector, Mr. Michael Kido, Extension Specialist, Hawaii Institute of Tropical Agriculture and Human Resources, University of Hawaii. Mr. Kido's interest in the stream fauna of Kauai Island resulted in the discovery of this unusual eucoilid.

Aspidogyrus kidoi is most similar to *A. mirabilis* from Hawaii Island. It can be distinguished by the presence of integumental sculpture on the temples and vertex of the head, the more strongly developed integumental sculpture of the mesosoma, and the somewhat larger compound eye and shorter malar space, than in *mirabilis*.

Aspidogyrus macioleki, new species.

Female: Length 1.5mm, forewing 1.6mm. Mesosoma black; head very dark brown; tegulae, gaster, hind legs, except trochanter and tarsus, brown; mandible, antenna and remainder of legs yellowish brown to yellow; wing veins pale (specimen originally collected into alcohol and may have been decolorized). Head slightly narrower than mesosoma (5:6), in dorsal aspect about $\frac{3}{5}$ as long as wide; front between eyes about twice as wide as eye; posterior ocelli separated from anterior ocellus by distance greater than 1.5 times maximum ocellus width; malar space relatively long, approximately equal to height of compound eye, subocular suture obsolete. Head smooth, shining, without sculpture except series of 4-5 short, fine, transverse grooves immediately below antennal toruli. Antenna about as long as body or slightly longer, slender, form as in other species of this genus, third segment (basal flagellomere) longest, segments 4-6 subequal, 7 and 8 slightly shorter, 9-12 progressively shorter and slightly broader, 13 about as long as 11; rhinaria apparently confined to segments 8-13. Antenna nearly devoid of setae, except for a few very short fine hairs on upper margins of basal flagellomeres.

Pronotal plate well-defined, posterior (upper) and lateral margins forming fine ridge, general shape and sculpture as in *A. mirabilis*. Sides of pronotum finely, strongly areolate-rugose, with several diagonally longitudinal carinulae extending from lateral margin of pronotal plate and margin of pronotal groove next to margin of propleuron. Mesoscutum mostly smooth, shining, relatively weakly sculptured with anastomosing carinulae in narrow band on lateral margin anterior to tegula, but not extending anteriorly to pronotal margin; notaulices weakly indicated on anterior half

of scutum. Scutellum somewhat truncate behind, extending slightly over base of propodeum, form and sculpture as in *A. mirabilis*, disc with strong, coarse areolate-rugose sculpture, basal fossae shallow, surfaces with diagonal carinulae. Scutellar plate smooth, shining, extending for about $\frac{1}{3}$ length of disc, nearly flat with a narrow, declivous, anterior neck; subapical pit moderately small. Mesopleuron areolate-rugose throughout, with some stronger longitudinal carinulae indicated, particularly near anterior border, mesopleural suture obsolete; metapleuron areolate-rugose; posterior marginal ridge apparently entire. Propodeum, metanotum, and side of scutellum near wing base with pile of fine setae; a few fine setae scattered on posterior part of scutellar disc, mesosoma otherwise largely hairless.

Legs elongate, but less extremely so than *A. mirabilis*, apical tarsomere plus pretarsus of hind leg as long as 2 basal tarsomeres combined; pretarsus (fig. 2B) with empodium very large and fleshy, claws with a single apical hook, and a comb-like structure composed of 5-6 fine straight projections on inner face.

Wings as in *A. mirabilis* except wing veins decidedly paler (may be due to decolorization of the type specimen in alcohol).

Gaster smooth, shining, without basal hair ring, except for one or two setae on sides; posterior tergites exposed only at apex.

Male: unknown.

Described from a single female holotype: Hawaiian Islands: Oahu I., Punaluu Stream 900 ft., 3-X-1967, J. Maciolek, collector; associated with larvae of *Procanace* sp. on large rubble in pool. T. 21 degrees Celsius.

Dr. Maciolek originally sent the holotype specimen and associated parasitized *Procanace* larvae to Dr. K.S. Hagen at the University of California, Division of Biological Control in Albany, California. Dr. Hagen kindly made this material available to me upon learning of my interest in Hawaiian eucoilids. I removed the specimen from alcohol, dried and mounted it (paper point).

The species is named in honor of its collector, Dr. John Maciolek, formerly with the U.S. Department of Interior, Fish and Wildlife Service, Hawaii Cooperative Fishery Unit. Dr. Maciolek collected the type specimen in connection with his studies on the biota of Hawaiian streams.

A. macioleki appears most closely related to *A. kidoi* from Kauai and *A. mirabilis* from Hawaii I. It is distinguished from both species by the unusual structure of the pretarsus, and the largely smooth, shining mesoscutum.

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